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DOE-STD-1090-2001
April 2001
Superseding
DOE-STD-1090-99
March 1999

DOE STANDARD

HOISTING AND RIGGING
(Formerly Hoisting and Rigging Manual)

U.S. Department of Energy
Washington, D.C. 20585

AREA SAFT

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Summary of Changes as of 2001

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History and Background

In 1975, cognizant safety and health personnel at the U.S. Department of Energy (DOE) Headquarters (HQ) met to discuss the need for a DOE hoisting and rigging manual. At that meeting, existing, applicable hoisting and rigging codes, standards, and regulations, such as the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, the American National Standards Institute (ANSI) B-30 series, and others, were reviewed in detail. Subsequently, it was determined that these documents, while adequate as minimum general industry standards, did not contain the detail necessary to adequately accomplish the extremely complex, critical, and hazardous hoisting and rigging operations being performed at DOE sites, in all probability, at other government agency and private sectors throughout the country. Because of the high potential for accidents that could result in significant property loss or serious personnel injury or death, it was decided that a DOE hoisting and rigging manual was not only desirable but absolutely necessary.

Preliminary work on the manual was initiated in 1976. The manual that was developed at that time incorporated the minimum requirements of OSHA, ANSI, and similar documents and also included additional more stringent requirements deemed necessary to adequately control hoisting and rigging work processes throughout DOE. Each phase of the manual was then critically reviewed by DOE and contractor personnel. A final draft was completed in 1978 and implemented on a trial basis.

In June 1980, a decision was made to formally issue and distribute the manual under controlled distribution, an arrangement where the manual must be specifically requested from the originating source; however, once requested, updates are automatically received through an actively maintained distribution list. In 1982, the manual was included as a reference standard in DOE 5480.4, "Environmental Protection, Safety, and Health Protection Standards." Updates and improvements have been made over the years on an approximately annual basis. Revisions have occurred in 1984, 1985, 1986, 1988, 1989, 1993, 1995, 1996, 1999, and 2001 to clarify intent, comply with OSHA and ANSI B-30 changes, improve format, strengthen wording, delete needless redundancy, eliminate obsolescence, and the like. Prior to inclusion in the manual, all changes must be approved by the DOE Hoisting and Rigging Technical Advisory Committee, which meets annually, and by the Headquarters Office of Occupational Safety and Health Policy, which has safety responsibility for DOE hoisting and rigging. The Committee is also a major source for input into the manual, particularly concerning those areas that are not defined or are only generally defined by Federal and national standards, such as training and qualification, and those concerning the DOE's unique operational environment, such as hoisting and rigging over nuclear reactors and other locations containing critical equipment. In the years that minor revisions occur, only the changed pages, usually 8 to 10, are sent to individuals on the distribution list. After two to three such supplements, the manual is reissued in its entirety, which incorporates the previous supplements plus the most recent unpublished changes approved by the committee. An example is the complete revision issued in 1993 followed by another complete revision in 1996, 1999 and 2001, without any intervening supplements. In this case, the supplements were omitted because of the numerous improvements incorporated within the very short time period. Some of the most notable changes in the current standard include:

1. Full compliance with OSHA and ANSI requirements, with the OSHA requirements having priority where conflicts exist.

2. Expansion of Chapter 6 to include greater detail on qualifications for a larger number of positions. Criteria to be evaluated in training programs have likewise been expanded, enabling sites to tailor training programs to their particular characteristics.

3. The complete reformatting of each section into major equipment categories so that the handbook is easier to use.

4. The use of double-column format along with a slightly larger font size which improves readability. The double-column format has the added advantage of placing figures and tables closer to their referencing text.

5. Labeling of the side-by-side good practice, bad practice drawings so that the information being conveyed is immediately apparent. Also, in some cases portions of drawings containing key information, such as hand signals, finger positions were difficult to discern. These have been retouched.

6. This document contains many common element requirements which differ slightly in wording when applied to a specific equipment type. These differences have been compared, and whenever appropriate, the most comprehensive (and clearest) wording has been used.

7. To improve readability, the writing style has been changed to the active voice, which reduces, to some extent, the use of the word "shall," indicating a mandatory requirement. The reader should note that the use of the active (imperative) voice, such as "ensure that, check for, use only," indicates a mandatory requirement even if the word "shall" is not present in the sentence.

8. The reissued June '95 edition marked a change in classification. The DOE Office of Scientific and Technical Information (OSTI) reclassified the manual as a handbook and was issued as DOE Hoisting and Rigging Handbook (DOE-HDBK-1090-95). After further review, OSTI has reclassified the handbook as a DOE Technical Standard and the September 1996 edition ~~is~~ was issued as DOE STANDARD HOISTING AND RIGGING (Formerly Hoisting and Rigging Manual), DOE-STD-1090-96 (Rev-1), DOE-STD-1090-99 and DOE-STD-1090-2001.

While *The Hoisting and Rigging Standard* is in itself a best practice document, much of its content, such as the OSHA, ANSI/ASME, and Crane Manufacturers Association of America standards, is mandatory within DOE. In addition, many DOE organizations have, on their own initiative, adopted the standard as mandatory to ensure safe and proper hoisting and rigging operations at their facilities. Whether mandatory or not, the standard is and will continue to be the standard by which the excellence of DOE hoisting and rigging programs are judged.

CHAPTER 1 TERMINOLOGY AND DEFINITIONS

~~**CRITICAL ITEM:** A part, assembly, component, or piece of equipment designated as critical by a purchaser or facility operator, because the dropping, upset, or collision of it could: (a) cause damage that would result in schedule delay, (b) cause undetectable damage that could jeopardize future operation or the safety of the facility, © result in significant release of radioactivity or other undesirable condition, or (d) present a potentially unacceptable risk of personnel injury or property damage. Critical items may include pumps, heat exchangers, piping subassemblies, other primary-system components, fuel assemblies, large radiation-shielded shipping casks, or other items that require special care in handling because of size, weight, installation in close-tolerance receptors, fragility, extreme susceptibility to damage, or other unusual factors.~~

~~**CRITICAL SERVICE:** The use of equipment or tackle for hoisting, rigging, or handling of critical items.~~

FATIGUE: ~~A term commonly applied to progressive fracture of any load-supporting member.~~ The tendency of a material to break under repeated stress.

LIFT, CRITICAL: ~~Lifting of parts, components, assemblies, or other items designated as critical because the effect of dropping, upset, or collision of them could.~~ A lift for which the application of requirements applicable to ordinary lifts would not adequately eliminate or control the likelihood or severity of the following:

- o ~~Present a potentially unacceptable risk of personnel injury or property damage.~~ personnel injury or significant adverse health impact (onsite or offsite)
- o ~~Result in~~ significant release of radioactivity or other hazardous material or other undesirable conditions
- o ~~Cause~~ undetectable damage that would jeopardize future operations or the safety of a facility ~~resulting in future operational or safety problems~~
- o ~~Cause significant work delay~~ damage that would result in delay to schedule or other significant program impact such as loss of vital data.

PERSON-IN-CHARGE (PIC): The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads. ~~and for the safe handling of noncritical items in, around, or above spaces in which critical items are located.~~

SHOP CRANE: A Portable Automotive Lifting Device (PALD), self contained hydraulic and pneumatic-hydraulic crane characterized by a pair of laterally spaced legs, an upright mast, a pivoting boom with a boom extension and hook, and a hydraulic unit. The hydraulic unit moves the boom up and down at a pivot point for the purpose of raising, removing, transporting in the lowered position, and replacing automotive engines, transmissions and other components. Shop cranes have a capacity of 4 tons (8000 pounds) or less.

SUSPECT/COUNTERFEIT ITEMS (S/CI) : A suspect item is one in which visual inspection, testing, or other means indicate that it may not conform to established Government or industry-accepted specifications or national consensus standards. A counterfeit item is a suspect item that has been copied or substituted without legal right or authority to do so or one whose material, performance, or characteristics are knowingly misrepresented by the vendor, supplier, distributor, or manufacturer (see Figure 1-6). NOTE: (refer to DOE G 440.1-6 “Implementation Guide For Use With Suspect/Counterfeit Requirements” of DOE O 440.1, Worker Protection Management).

CHAPTER 2 CRITICAL LIFTS

b. A lift shall be designated as a critical lift if ~~collision, upset, or dropping could result in any of the following~~ the requirements applicable for ordinary lifts do not adequately eliminate or control the likelihood or severity of the following:

1. ~~Unacceptable risk of~~ Personnel injury or significant adverse health impact (onsite or offsite).

2. Significant release of radioactive or other hazardous material or other undesirable conditions.

3. Undetectable damage that would jeopardize future operations or the safety of a facility.

4. Damage that would result in ~~unacceptable~~ delay to schedule or other significant program impact such as loss of vital data.

CHAPTER 4 LIFTING PERSONNEL

Chapter 4 was totally re-written to ensure all applicable requirements of 29 CFR 1926.550(g) " Crane or Derrick Suspended Personnel Platform," and ASME B30.23 "Personnel Lifting Systems" are incorporated.

CHAPTER 6 PERSONNEL QUALIFICATIONS AND TRAINING

6.2.1 General

Only qualified personnel or trainees, under the direct supervision of qualified personnel, who meet the following requirements shall be allowed to rig, operate, inspect, or perform maintenance on cranes, hoists, or powered forklift trucks:

6.2.4 Operators of Truck Mounted Cranes - Capacity 1 Ton or Less

a. Physical qualifications shall be based on specific job requirements.

b. Operators shall be required by their employer to pass a practical operating skill evaluation. Qualification shall be limited to the type of equipment for which the operator is being evaluated.

6.2.10 Inspectors

b. Employees who operate cranes to perform crane inspections shall be trained and qualified to operate the crane on which the inspection is being performed. See general and crane specific qualification requirements in section 6.2. "Qualification."

c. Crane operation by crane inspectors shall be limited to those crane functions necessary to perform the inspection on the crane.

6.2.13 Maintenance Personnel

a. Employees who operate cranes to perform crane maintenance shall be trained and qualified to operate the cranes on which maintenance is being performed. See general and crane specific qualification requirements in section 6.2. "Qualification."

b. Crane operation by maintenance personnel shall be limited to those crane functions necessary to perform maintenance on the crane or to verify the performance of the crane after maintenance has been performed.

c. Employees who perform maintenance activities on equipment covered by this standard should have an understanding of the following criteria:

1. The tools to safely accomplish their work.

2. Access to operating instructions to perform adjustments.

3. Parts information furnished by the manufacturer or the responsible maintenance/engineering organization.

4. Manufacturers' recommendations as to points and frequency of lubrication and levels and types of lubricant to be used.

5. Maintenance and repair procedures recommended by the manufacturer or responsible maintenance/engineering organization.

6. Wiring diagrams.

7. Documentation requirements for maintenance and repair.

6.3.1 General

a. Organizations that employ personnel who operate, rig, inspect, or perform maintenance on equipment covered in this standard shall provide training programs, including a means of evaluation, to ensure that the personnel are competent to perform the operations.

6.3.4 Operators of Truck Mounted Cranes - Capacity 1 Ton or Less

a. Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate truck mounted cranes - capacity 1 ton or less.

b. The initial training of operators shall include applicable training on equipment for which qualification is sought, under the direction of a qualified operator or instructor.

c. Instructor review of the applicant's knowledge, including results of written and oral evaluation, and witnessing a demonstration of the operator's skills.

d. Operators should be able to demonstrate a knowledge of equipment operating characteristics, capabilities, limitations, effects of variables, safety features, and operating procedures.

6.3.5 Forklift Truck Operators

d. The following checklist contains basic factors with which a forklift operator should be familiar as they relate to workplace topics.

1. Surface conditions where the forklift will be operated.

2. Composition of loads to be carried and load stability.

3. Load manipulation, stacking, and unstacking.

4. Pedestrian traffic in areas where the forklift will be operated.

5. Narrow aisles and other restricted places where the forklift will be operated.

6. Hazardous (classified) locations where the forklift will be operated.

7. Ramps and other sloped surfaces that could affect the forklift’s stability.

8. Closed environments and other areas where insufficient ventilation or poor vehicle maintenance could cause a buildup of carbon monoxide or diesel exhaust.

9. Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation.

6.3.7 Inspectors

d. Employees who operate cranes to perform crane inspections shall be trained and qualified to operate the crane on which the inspection is being performed. See general and crane specific training requirements in section 6.3. *Training*.

6.3.9 Maintenance Personnel

a. Employees who operate cranes to perform crane maintenance shall be trained and qualified to operate the cranes on which maintenance is being performed. See general and crane specific training requirements in section 6.3. *Training*.

CHAPTER 7 OVERHEAD and GANTRY CRANES

7.2.7.1 Cranes

In addition to the requirements of Section 7.2.6, "Frequent Inspections," periodic inspections shall include the following:

a. Components for deformation, cracks, or corrosion.

b. Bolts, rivets, nuts, and pins for being loose or absent.

c. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

d. Sheaves and drums for cracks or wear.

7.4.1 Operating Equipment

a. A preventive maintenance program shall be established and based on the recommendation of the crane manufacturer. ~~or a qualified person.~~ If manufacturer's recommendations are no longer available, a qualified person shall establish the program's requirements. Dated records should be kept where readily available to appointed personnel.

CHAPTER 8 HOISTS

8.2.5.1 Hoists

a. In addition to the requirements listed in Section 8.2.4, "Frequent Inspection," periodic inspections of hoists shall include the following:

1. Loose fasteners.

2. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

3. Cracked or worn drums or sheaves.

8.4 Maintenance

a. A preventive maintenance program shall be established and be based on the hoist manufacturer's recommendations. If manufacturer's recommendations are no longer available, a qualified person shall establish the program's requirements. Dated records should be kept where readily available to appointed personnel.

CHAPTER 9 MOBILE CRANES

9.2.6.1 Cranes

Inspect for:

a. Deformed, cracked, or corroded members in the crane structure and entire boom.

b. Loose bolts or rivets.

c. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

d. Cracked or worn sheaves and drums.

9.4.1 Preventive Maintenance

~~a. A preventive maintenance program based on the crane manufacturer's recommendations should be established. Dated records should be made available.~~

a. A preventive maintenance program shall be established and based on the recommendation of the crane manufacturer. If manufacturer's recommendations are no longer available, a qualified person shall establish the program's requirements. Dated records should be kept where readily available to appointed personnel.

CHAPTER 10 FORKLIFT TRUCKS

10.3.3 Inspection and Maintenance

e. Carefully inspect all parts of lift and tilt mechanisms and frame members and maintain them in a safe-operating condition.

f. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

g. For special trucks or devices designed and approved for operation in hazardous areas, ensure that the original, approved safe-operating features are preserved by maintenance.

10.5.1.2 Traveling

p. When stacking or tiering, use only enough backward tilt to stabilize the load.

~~q. Do not rig loads from the tines of a forklift truck, (attaching rigging to the forks to support a suspended load) without written management approval.~~

q. Rigging loads from the tines of a forklift, (attaching rigging to the forks to support a suspended load) shall only be performed by qualified personnel in accordance with approved site procedures.

r. Never lift with one fork without an engineering analysis and approval.

s. Use guides and signalers as necessary. If in doubt, check the conditions personally before proceeding. Standard hand signals are shown in Figure 10.5 "Hand Signals."

t. Do not block fire extinguishers, fire protection sprinklers, or alarm stations when stacking loads.

CHAPTER 11 WIRE ROPE & SLINGS

11.3.1 General

d. ~~Slings shall be secured or terminated at the crane hook so that the sling does not reeve or slip through the hook.~~ Rigging shall be configured such that slings do not reeve or slip through the hook. To attach the load, locate the center of gravity, position the crane hook directly above the center of gravity, and then rig the load so that it will lift level and true.

11.3.2.2 Proof-Testing

a. All swaged socket and poured socket sling assemblies shall be proof-tested to the wire rope or fitting manufacturers recommendations but in no case greater than 50 percent of the component wire ropes' or structural strands' nominal strength. All other sling assemblies shall be proof- tested when specified by the purchaser.

11.3.2.3 Operation

a. The following shall apply to all personnel who use wire-rope slings:

9. Rigging shall be configured such that slings do not reeve or slip through the hook.

11.3.2.4 Critical Lifts

1. All provisions of paragraph 11.3.2.3.a, also shall apply to critical lifts.

2. Wire-rope slings used for critical-lift service shall have an initial proof load test. If proof testing cannot be verified, the wire-rope sling(s) shall be proof tested before being used to make a critical lift. As a minimum, the proof load shall be equal to the rated capacity but shall not exceed:

I. All swaged socket and poured socket sling assemblies shall be proof-tested to the wire rope or fitting manufacturers recommendations but in no case greater than 50 percent of the component wire ropes' or structural strands' normal strength.

ii. 125 percent of the vertical rated capacity of single-leg, hand-tucked slings.

iii. 200 percent of the vertical rated capacity for mechanical-spliced single-leg slings and endless slings.

iv. The proof- load for multiple-leg bridle slings assemblies shall be applied to the individual leg and shall be in accordance with paragraph I, ii., and iii. as applicable.

v. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

11.3.3.5 Critical Lifts

a. Single-leg and endless alloy-steel chain slings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

11.3.4.4 Critical Lifts

a. Metal-mesh slings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

11.3.5.1 Inspection

d. Slings shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.

2. Melting or charring of any part of the surface.

3. Snags, punctures, tears, or cuts.

4. Broken or worn stitches.

5. Wear or elongation exceeding the amount recommended by the manufacturer.

6. Distortion of fittings.

7. Knots in any part.

8. Missing or illegible sling identification.

11.3.5.4 Critical Lifts

a. Synthetic-web slings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

11.3.6 Synthetic Roundslings

a. Synthetic roundslings shall possess the following qualities:

1. Core yarn shall be of a synthetic fiber wound together on a plurality of turns for even distribution of the load.

2. In chemically active environments the cover shall be the same type yarn as the load bearing core.

3. The thread used in the manufacture of a synthetic roundsling shall be of the same type of material as the core.

4. Finishes and coatings shall be compatible with material of the core, cover, and thread and not impair the performance of the roundsling.

b. Fittings shall be:

1. Of sufficient strength to sustain twice the rated capacity without permanent deformation.

2. Of a minimum breaking strength equal to that of the roundsling.

3. Free of all sharp edges that would in any way damage the roundsling.

4. Compatible with the mechanical and environmental requirements imposed on the roundsling.

c. The roundsling manufacturer should be consulted before roundslings are used in chemically active environments.

d. Do not use Polyester roundslings at temperatures in excess of 194 degrees F (90 degrees C) or temperatures below -40 degrees F (-40 degrees C).

e. The design factor for synthetic roundslings shall be a minimum of 5:1 based on breaking strength.

f. Rated capacities are affected by the type of hitch used and by the angle from the vertical when used as multi legged slings or in basket hitches. The sling manufacturer shall supply data on these effects.

g. Despite their inherent toughness, synthetic roundslings can be cut by repeated use around sharp-cornered objects. They eventually show signs of abrasion when they are repeatedly used to hoist rough-surfaced products. There are, however, protective devices offered by most sling manufacturers that minimize these effects.

h. Synthetic roundslings are available in a number of configurations (see Figure 11-21).

I. The roundsling capacities listed in Table 11-16 are approximate only. The capacities are also based on a 5:1 design factor and assume that the end fittings are of adequate strength.

11.3.6.1 Inspections

a. Users of synthetic roundslings shall visually inspect all slings before each use.

b. Annual inspection shall be made by a qualified inspector, and inspection records shall be kept on file and readily available.

c. When it is necessary to use a polyester or nylon roundsling in a radiation area, the responsible manager shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

d. Slings shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.

2. Melting or charring of any part of the surface.

3. Snags, punctures, tears, cuts, or abrasive wear that expose the core yarns.

4. Broken or worn stitches in the cover which exposes the core yarns.

5. Wear or elongation exceeding the amount recommended by the manufacturer.

6. Stretched, cracked, worn, pitted or distortion of fittings.

7. Knots in any part.

8. Missing or illegible sling identification.

A sample periodic inspection form is included as Exhibit III at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

11.3.6.2 Proof-Testing

a. When specified by the purchaser, web slings of all types shall be certified as having been proof-tested prior to initial use.

1. The proof load for roundslings shall be 200 percent of the vertical rated capacity.

2. The proof load for multiple-leg roundslings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of the roundsling. Master links to which multiple-leg roundslings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

b. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

11.3.6.3 Operation

The following shall apply to all personnel who use roundslings:

a. Determine the weight of the load.

b. Select a sling having suitable characteristics for the type of load, hitch, and environment.

c. Ensure that slings with end fittings that are used in a choker hitch have sufficient length so that the choking action is on the body of the sling.

d. In slings used in a basket hitch, balance the load to prevent slippage.

e. Do not drag slings across the floor or over any abrasive surface.

f. Do not twist or tie slings into knots.

g. Protect slings from being cut by sharp corners, sharp edges, and highly abrasive surfaces.

h. Do not pull slings from under loads when a load is resting on a sling.

i. Do not use roundslings to lift loads in excess of the rated capacity, properly derated for other than straight-pull configuration.

j. Store roundslings to prevent mechanical or chemical damage.

k. Personnel should never stand in line with or next to a roundsling that is under tension.

l. If extreme temperatures are involved, ensure the guidance in 11.6.d is followed.

m. Do not allow the load, hook, or any fitting to constrict, bunch, or pinch roundslings.

n. Ensure that roundslings are <u>not</u> used as bridles on suspended personnel platforms.

o. For multiple leg roundslings used with non-symmetrical loads, an analysis should be performed by a qualified person to prevent overloading of any leg.

p. Ensure that each sling is permanently marked to show:

1. Name or trademark of manufacturer.

2. Manufacturer's code or stock number.

3. Rated capacity for types of hitches used.

4. Type of core material and cover material if different from core material.

NOTE: Slings may be marked with a serial number or other identifying number that can be used to determine capacity in situations where it becomes impossible to mark the sling as described above due to security classification of the loads to be lifted or for other valid reasons approved by the responsible manager.

q. Ensure that roundslings are marked with the inspection due date. This information may be stenciled or stamped on a metal tag affixed to the sling.

11.3.6.4 Critical Lifts

a. Synthetic roundslings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg Synthetic roundslings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

CHAPTER 12 RIGGING ACCESSORIES

12.1.2 Testing

~~a. Tackle assemblies, handling fixtures, and rigging accessories for critical-lift service shall have an initial proof-load test of 2 times the rated capacity. If proof-testing cannot be verified, the tackle shall be proof-tested before being used to make a critical lift.~~

~~b. Tackle assemblies, handling fixtures, and rigging accessories shall be tested as a unit when practical. When necessary, parts of such assemblies may be tested individually with the approval of the inspector.~~

~~c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values.~~

~~d. All parts showing damage or permanent deformation as a result of load-testing shall be replaced. Replacement parts shall be load-tested in accordance with this paragraph. Discarded parts shall be destroyed.~~

a. Multileg lift assemblies shall be load-tested based on any two legs sharing the entire load. Attach legs not undergoing test in a manner to ensure that load stability is not lost during the test.

b. Dynamometers and load cells shall be ~~tested and~~ calibrated at least once a year and when specified in the critical lift procedure before being used to make a critical lift. This also applies if they have not been used in the previous 6 months. All calibrated devices shall have a tag affixed indicating date of calibration, by whom they were calibrated, and the date that the next calibration is due.

12.2.5.4 Periodic Inspection

a. A qualified inspector shall perform a complete inspection at the following intervals:

1. Normal service—yearly.

2. Heavy service—semiannually.

3. Severe service—quarterly.

b. A qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard.

c. The inspection shall include the requirements of Section 12.2.5.3, "Frequent Inspection."

~~d. Hooks shall receive a nondestructive examination according to applicable ASTM standards annually.~~

~~e~~.d. Hooks having any of the following conditions shall be removed from service until repaired or replaced:

1. Deformation—Any bending or twisting exceeding 10 degrees (or as recommended by the manufacturer) from the plane of the unbent hook.

2. Throat opening—Any distortion causing an increase in throat opening exceeding 15 percent (or as recommended by the manufacturer).

3. Wear—Any wear exceeding 10 percent (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

4. Cracks.

12.2.6 Testing

a. Hooks not attached to slings or other lifting hardware shall be proof tested to 200 percent of the rated capacity prior to initial use. The test load shall be accurate to within -5 percent, +0 percent of stipulated values.

b. For critical lifts, if proof testing cannot be verified, the hook(s) shall be proof tested before being used to make critical lifts.

c. No performance testing of hooks shall be required, except as is necessary to conform to the requirements for the slings or rigging hardware of which they are a part.

d. If detailed inspections are performed (refer to Sections 12.2.5.2.b, 12.2.5.3.d, and 12.2.5.4.c), the results shall be evaluated by a qualified person to determine the need for subsequent nondestructive testing (NDT). If NDT is deemed necessary, it shall be performed in accordance with Section 13.4.3.

12.3.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Shackles used for critical-lift service shall have an initial proof load test of 200 percent of the rated capacity. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values. If proof testing cannot be verified, the shackle(s) shall be proof tested before being used to make a critical lift.

12.4.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Eyebolts used for critical-lift service shall have an initial proof load test of 200 percent of the rated capacity. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values. If

proof testing cannot be verified, the Eyebolts shall be proof tested before being used to make a critical lift.

12.5.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Turnbuckles used for critical-lift service shall have an initial proof load test of 200 percent of the rated capacity. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values. If proof testing cannot be verified, the tunbuckles shall be proof tested before being used to make a critical lift.

12.6.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Links and rings used for critical-lift service shall have an initial proof load test of 200 percent of the rated capacity. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values. If proof testing cannot be verified, the links and/or rings shall be proof tested before being used to make a critical lift.

12.7 SWIVEL HOIST RINGS

12.7.1 General

a. The following shall apply when using swivel hoist rings for hoisting:

1. They shall be fabricated from forged carbon or alloy steel.

2. Have a minimum design factor of 5:1.

3. The working load limit shall forged, stamped, or inscribed into each swivel hoist ring by the manufacturer. Have a permanently attached metal tag bearing the same information may also be used.

4. They shall have a class II fit and have a minimum thread engagement as recommended by the manufacturer.

5. When installed with a retention nut, follow the manufacturer recommendations.

b. The following shall apply to swivel hoist ring users:

1. Never use spacers between bushing flange and mounting surface.

2. Install hoist ring to recommended torque with a calibrated torque wrench making sure the bushing flange meets the load (work piece) surface. Unless specific torque requirements are specified for the load (work piece) being lifted, the minimum recommended torque shall be as specified by the hoist ring manufacturer. Maximum recommended torque requirements specified by the manufacturer should not be exceeded.

3. When load is applied to the hoist ring; there should be no interference between the load (work piece) and the hoisting ring. The hoist ring should be able to swing or rotate freely under load (See Fig. 1 & 2)

4. Carefully inspect each swivel hoist ring before use (Ref. Fig. 3 & 4). Visually inspect the hole to ensure that there has ben no deformation. Check the condition of the threads in the hole to ensure that the hoist ring will secure and the bushing can be brought down snug. Destroy hoist rings that are cracked, bent, have damaged threads, or do not operate freely.

5. Permanently installed hoist rings shall be inspected before each use to ensure free movement of bail and swivel. Refer to specific requirements for load (work piece) with permanently installed hoist rings, before checking or re-torquing.

12.7.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Swivel hoist rings used for critical-lift service shall have an initial proof load test of 200 percent of the rated capacity. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values. If proof testing cannot be verified, the swivel hoist ring(s) shall be proof tested before being used to make a critical lift.

12.8 LOAD INDICATING DEVICES

c. Dynamometers ~~commonly have~~ shall have a design factor of not less than 3:1. ~~less than 5:1. Any combination where the safety factor of the dynamometer times the capacity of the dynamometer divided by the load equals 5 is acceptable.~~

c. Dynamometers shall have a design factors of not less than 3:1.

~~d. When dynamometers are used as load-bearing parts of rigging, they must be constructed to provide a measure of safety and reliability equal to that of the associated rigging, or a safety device must be installed to prevent dropping the load in the event of a failure.~~

12.9 PRECISION LOAD POSITIONERS

12.9.2 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Precision load positioners used for critical-lift service shall have an initial proof load test confirming the load rating. If proof testing cannot be verified, the precision load positioners shall be proof tested before being used to make a critical lift.

CHAPTER 13 LOAD HOOKS

13.3 TESTING

a. Each new or replacement hook of 150-ton capacity or greater and a prototype of each hook design of less than 150-ton capacity shall be proof-tested by the manufacturer in accordance with Table 13-1.

13.4 NONDESTRUCTIVE TESTING (NDT)

13.4.1 NDT Requirements

a. For crane and hoist hooks of 10-ton rated capacity or greater that are assigned to heavy or severe service, a qualified inspector shall perform an NDT at the following intervals:

1. Heavy service: annually.

2. Severe service: semiannually.

~~b. A designated person or a qualified inspector shall perform an NDT for other hooks when deemed necessary for site-specific reasons.~~

b. If detailed inspections are performed (refer to Sections 13.2.3.b., 13.2.4c., and 13.2.5.b.), the results shall be evaluated by a qualified person to determine the need for subsequent nondestructive testing (NDT). If NDT is deemed necessary, it shall be performed in accordance with Section 13.4.3.

~~c. If visual examination reveals a surface intersecting discontinuity (i.e., stress or fatigue cracks), a twist, increased throat opening, or any other defect, an NDT shall be performed to evaluate the hook further, regardless of its rated capacity or service classification.~~

CHAPTER 14 BELOW-THE-HOOK LIFTING DEVICES

14.2.5.3 Periodic Inspection

c. This inspection shall include the items listed in Section 14.2.5.2, "Frequent Inspection," in addition to the following:

1. Loose bolts or fasteners.

2. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

3. Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, and belts.

14.2.10 Critical Lifts

a. See Chapter 2, "Critical Lifts," for critical lift requirements.

b. Structural and mechanical lifting devices for critical-lift service shall have an initial proof-load test of not more than 125 percent of its rated capacity. If proof-testing cannot be verified, the lifting device shall be proof-tested before being used to make a critical lift.

14.3.4.3 Periodic Inspection

c. This inspection shall include those conditions or items specified in Section 14.3.4.2, "Frequent Inspection," in addition to the following:

1. External evidence of looseness, wear, deformation, cracking, or corrosion.

2. External evidence of damage to supporting structure, motors, controls, and other auxiliary components.

3. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

14.3.9 Critical Lifts

a. See Chapter 2, "Critical Lifts," for critical lift requirements.

b.. Vacuum lifting devices for critical-lift service shall have an initial proof-load test of not more than 125 percent of its rated capacity. If proof-testing cannot be verified, the lifting device shall be proof-tested before being used to make a critical lift.

14.4.4.3 Periodic Inspection

c. This inspection shall include those items specified in Section 14.4.4.2, "Frequent Inspection," in addition to the following:

1. Deformation, wear, and corrosion of all members, fasteners, locks, switches, warning labels, and lifting parts.

2. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

3. Operation and condition of electrical components (i.e., meters, indicators, and alarms).

14.4.9 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. General-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed the rated load (capacity) by a factor of at least 2. If the rated breakaway-force test cannot be verified, the lifting device shall be required to satisfy the rated breakaway-force test before being used to make a critical lift.

b. Specified-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed the rated load (capacity) by a factor of at least 2. If the rated breakaway-force test cannot be verified, the lifting device shall be required to satisfy the rated breakaway-force test before being used to make a critical lift.

14.5.4.3 Periodic Inspection

c. This inspection shall include those items specified in Section 14.5.4.2, "Frequent Inspection," in addition to the following:

1. Deformation, wear, and corrosion of all members, fasteners, and lifting parts.

2. Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).

3. Proper operation and condition of electrical components.

14.5.9 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

a. Remote-operated magnets for critical-lift service shall have been tested for proper operation of all electrical equipment and a visual inspection of the lifting device for defects. If testing and inspection cannot be verified, the lifting device shall be tested and inspected before being used to make a critical lift.

CHAPTER 15 CONSTRUCTION EQUIP. REQUIREMENTS

15.2 DEFINITIONS

LIFT, CRITICAL: ~~Lifting of parts, components, assemblies, or other items designated as critical because the effect of dropping, upset, or collision of them could.~~ A lift for which the application of requirements to ordinary lifts would not adequately eliminate or control the likelihood or severity of the following:

- ~~Present a potentially unacceptable risk of personnel injury or property damage.~~ personnel injury or significant adverse health impact (onsite or offsite)
- ~~Result in~~ significant release of radioactivity or other hazardous material or other undesirable conditions
- ~~Cause~~ undetectable damage that would jeopardize future operations or the safety of a facility ~~resulting in future operational or safety problems~~
- ~~Cause significant work delay~~ damage that would result in delay to schedule or other significant program impact such as loss of vital data.

PERSON-IN-CHARGE (PIC): The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads. ~~and for the safe handling of noncritical items in, around, or above spaces in which critical items are located.~~

15.3.2 Qualified Operators of Forklift Trucks

g. The following checklist contains basic factors with which a forklift operator should be familiar as they relate to workplace topics.

1. Surface conditions where the forklift will be operated.
2. Composition of loads to be carried and load stability.
3. Load manipulation, stacking, and unstacking.
4. Pedestrian traffic in areas where the forklift will be operated.
5. Narrow aisles and other restricted places where the forklift will be operated.
6. Hazardous (classified) locations where the forklift will be operated.
7. Ramps and other sloped surfaces that could affect the forklift's stability.
8. Closed environments and other areas where insufficient ventilation or poor vehicle maintenance could cause a buildup of carbon monoxide or diesel exhaust.
9. Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation.

15.3.4 Inspector

a. Qualified inspectors shall have the necessary knowledge and experience to properly inspect hoisting and rigging equipment.

b. Employees who operate hoisting equipment to perform inspections shall be trained and qualified to operate the equipment on which the inspection is being performed. See general and specific qualification requirements in section 15.3.1 and 15.3.2, *Personnel Qualification*.

c. Hoisting equipment operation by inspectors shall be limited to those equipment functions necessary to perform the inspection on the equipment.

15.3.5 Maintenance Personnel

a. Employees who operate hoisting equipment to perform hoisting equipment maintenance shall be trained and qualified to operate the equipment on which maintenance is being performed. See general and equipment specific qualification requirements in section 15.3.1 and 15.3.2, *Personnel Qualification*.

b. Hoisting equipment operation by maintenance personnel shall be limited to those equipment functions necessary to perform maintenance on the hoisting equipment or to verify the performance of the hoisting equipment after maintenance has been performed.

15.4.6.2 Synthetic Web Slings

b. A synthetic-web sling shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.
2. Melting or charring of any part of the surface.
3. Snags, punctures, tears, or cuts.
4. Broken or worn stitches.
5. Wear or elongation exceeding the amount recommended by manufacturers.
6. Distortion of fittings.
7. Knots in any part.
8. Missing or illegible sling identification.

15.4.6.4 Synthetic Round Slings

a. Users of synthetic roundslings shall visually inspect all slings before each use.

b. Annual inspection shall be made by a qualified inspector, and inspection records shall be kept on file and readily available.

c. When it is necessary to use a polyester or nylon roundsling in a radiation area, the responsible manager shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

d. Slings shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.
2. Melting or charring of any part of the surface.
3. Snags, punctures, tears, cuts, or abrasive wear that expose the core yarns.
4. Broken or worn stitches in the cover which exposes the core yarns.
5. Wear or elongation exceeding the amount recommended by the manufacturer.
6. Stretched, cracked, worn, pitted or distortion of fittings.
7. Knots in any part.
8. Missing or illegible sling identification.

15.4.7 Slings—Testing

15.4.7.1 Wire Rope

a. Wire-rope slings used for critical-lift service shall have an initial proof load test. If proof testing cannot be verified, the wire-rope sling(s) shall be proof tested before being used to make a critical lift. As a minimum, the proof load shall be equal to the rated capacity but shall not exceed:

1. All swaged socket and poured socket sling assemblies shall be proof-tested to the wire rope or fitting manufacturers recommendations but in no case greater than 50 percent of the component wire ropes' or structural strands' normal strength.

2. 125 percent of the vertical rated capacity of single-leg, hand-tucked slings.

3. 200 percent of the vertical rated capacity for mechanical-spliced single-leg slings and endless slings.

4. The proof- load for multiple-leg bridle slings shall be applied to the individual legs and shall be either 200 percent for mechanical splice or 125 percent for hand-tucked splice, times the vertical rated capacity of a single-leg sling.

5. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

15.4.7.2 Alloy-Steel Chain

a. Single-leg and endless alloy-steel chain slings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

15.4.7.3 Synthetic Web Slings

a. Synthetic-web slings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

15.4.7.4 Synthetic Round Slings

a. Synthetic roundslings used for critical-lift service shall have an initial proof load test of 200 percent of the vertical rated capacity. If proof testing cannot be verified, the sling(s) shall be proof tested before being used to make a critical lift.

b. The proof load for multiple-leg Synthetic roundslings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling.

c. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

15.4.9 Rigging Accessories—Testing

a. Rigging accessories for critical-lift service shall have an initial proof-load test of 2 times the rated capacity. The rigging accessories shall be proof-tested prior to making a critical lift if proof-testing cannot be verified.

b. Rigging accessories that have been modified or repaired shall be proof-tested again to 2 times the rated capacity prior to making a critical lift.

c. Multileg lift assemblies shall be proof-tested based on any two legs sharing the entire load. Attach legs not undergoing test in a manner to ensure that load stability is not lost during the test.

d. Dynamometers and load cells shall be calibrated at least once a year and when specified in the critical lift procedure before being used to make a critical lift. This also applies if they have not been used in the previous 6 months. All calibrated devices shall have a tag affixed indicating date of calibration, by whom they were calibrated, and the date that the next calibration is due.

15.4.10 Below-the-Hook Lifting Devices—Inspection

a. The operator or other designated person shall visually inspect each lifting device at the beginning of each shift or prior to use, if it has not been in regular service, for the following items or conditions (records are not required):

1. Structural deformation, cracks, or excessive wear on any part.

2. Loose or missing guards, fasteners, covers, stops, or nameplates.

3. All operating mechanisms and automatic hold-and-release mechanisms for misadjustments interfering with operation.

4. Loose bolts or fasteners.

5. Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, and belts.

6. Excessive wear of friction pads, linkages, and other mechanical parts.

7. Excessive wear at hoist-attaching points and load-support shackles or pins.

b. The operator or designated person shall carefully examine any deficiencies and determine whether they constitute a hazard. Deficiencies noted during the inspection shall be corrected before the lifting device is used.

15.4.11 Below-the-Hook Lifting Devices—Testing

a. Below-the-hook lifting devices for critical-lift service shall be proof-load tested. The rated capacity shall not be more than 80 percent of the maximum load sustained during the test. Test loads shall not be more than 125 percent of the rated capacity unless otherwise recommended by the manufacturer.

b. The lifting device shall be proof-tested prior to making a critical lift if proof-testing cannot be verified.

c. Lifting devices that have been modified or repaired shall be proof-tested again to 125 percent of the rated capacity prior to making a critical lift.

15.5.1 General

The following shall apply to all personnel involved in construction hoisting and rigging operations.

a. An appointed person shall classify each lift into one of the DOE categories (ordinary or critical), prior to planning the lift.

b. A lift shall be designated as a critical lift if ~~collision, upset, or dropping could result in any one of the following~~ the requirements for ordinary lifts do not adequately eliminate or control the likelihood or severity of the following:

1. Damage that would result in ~~unacceptable~~ delay to schedule or other significant program impact such as loss of vital data.

2. Significant release of radioactive or other hazardous material or other undesirable conditions.

3. ~~Unacceptable risk of~~ Personnel injury or significant adverse health impact (onsite or offsite).

4. Undetectable damage that would jeopardize future operations or the safety of a facility.

15.5.3.1 Attaching the Load

a. Ensure that the hoist rope is free of kinks or twists and is not wrapped around the load.

b. Attach the load to the load-block hook with slings or other approved devices.

c. Make certain that the sling clears all obstacles.

d. Do not hoist two or more separately rigged loads in one lift, even though the combined load is within the crane's rated capacity.

15.5.4.1.3 Loading

~~q. Do not rig loads from the tines of a forklift truck, (attaching rigging to the forks to support a suspended load) without written management approval.~~
q. Rigging loads from the tines of a forklift, (attaching rigging to the forks to support a suspended load) shall only be performed by qualified personnel in accordance with approved site procedures.

15.6 LIFTING PERSONNEL

Section 15.6 “Lifting Personnel” was totally re-written to ensure all applicable requirements of 29 CFR 1926.550(g) “ Crane or Derrick Suspended Personnel Platform,” 29 CFR 1910.178 “Powered Industrial Trucks,”ASME B30.23 “Personnel Lifting Systems,” and ASME B56.1 “Safety Standard for Low Lift and High Lift Trucks” are incorporated.

CHAPTER 16 MISCELLANEOUS LIFTING DEVICES

This is a new chapter and provides safety standards for the operation, inspection, testing, and maintenance for miscellaneous lifting devices, (truck mounted cranes - capacity 1 ton or less not covered in ASME B30.5 (“Mobile and Locomotive Cranes”) and implements the requirements of ASME PALD (“Portable Automotive Lifting Devices”) for self contained shop cranes.

CHAPTER 17 REFERENCES

American Society of Mechanical Engineers (ASME)

ASME B30.23, Personnel Lifting Systems

ASME PALD, Portable Automotive Lifting Devices.

ASME Cranes for Nuclear Facilities:

Nuclear Underhung and Monorail Cranes (NUM)

Nuclear Overhead and Gantry Cranes (NOG)

Department of Energy

DOE 440.1, Worker Protection Management for Federal and Contractor Employees

APPENDIX A PROCUREMENT GUIDELINES

7.1 SYNTHETIC SLINGS

a.8 EACH SLING SHALL BE PERMANENTLY MARKED WITH THE FOLLOWING:

A) Manufacturer's name or trademark.

B) Manufacturer's code or stock number.

C) Type of synthetic web material.

D) Rated loads for the type of hitches used.

NOTE: Hand written, or ink embossed markings are not acceptable. Sling tags shall be indelibly marked and the lettering shall not wear off with use. The markings shall remain legible for the life of the sling.

a.14. A load test certificate (LTC) shall be provided for each lot of slings supplied. The LTC shall reference as a minimum the PO number, date of proof test, amount of load applied, sling capacity, and lot/run number. The LTC shall be signed by the manufacturers authorized representative.

NOTE: Sling lengths shall be within a specified tolerance. Synthetic sling manufacturers normal length is ±1% of the sling length. If closer tolerance is required the purchaser should specifically request required tolerance on the purchase order.

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CONTENTS

CHAPTER 4 LIFTING PERSONNEL

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CHAPTER 15 CONSTRUCTION HOISTING AND RIGGING EQUIPMENT REQUIREMENTS

CHAPTER 16 MISCELLANEOUS LIFTING DEVICES

History and Background

In 1975, cognizant safety and health personnel at the U.S. Department of Energy (DOE) Headquarters (HQ) met to discuss the need for a DOE hoisting and rigging manual. At that meeting, existing, applicable hoisting and rigging codes, standards, and regulations, such as the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, the American National Standards Institute (ANSI) B-30 series, and others, were reviewed in detail. Subsequently, it was determined that these documents, while adequate as minimum general industry standards, did not contain the detail necessary to adequately accomplish the extremely complex, critical, and hazardous hoisting and rigging operations being performed at DOE sites, in all probability, at other government agency and private sectors throughout the country. Because of the high potential for accidents that could result in significant property loss or serious personnel injury or death, it was decided that a DOE hoisting and rigging manual was not only desirable but absolutely necessary.

Preliminary work on the manual was initiated in 1976. The manual that was developed at that time incorporated the minimum requirements of OSHA, ANSI, and similar documents and also included additional more stringent requirements deemed necessary to adequately control hoisting and rigging work processes throughout DOE. Each phase of the manual was then critically reviewed by DOE and contractor personnel. A final draft was completed in 1978 and implemented on a trial basis.

In June 1980, a decision was made to formally issue and distribute the manual under controlled distribution, an arrangement where the manual must be specifically requested from the originating source; however, once requested, updates are automatically received through an actively maintained distribution list. In 1982, the manual was included as a reference standard in DOE 5480.4, "Environmental Protection, Safety, and Health Protection Standards." Updates and improvements have been made over the years on an approximately annual basis. Revisions have occurred in 1984, 1985, 1986, 1988, 1989, 1993, 1995, 1996, 1999, and 2001 to clarify intent, comply with OSHA and ANSI B-30 changes, improve format, strengthen wording, delete needless redundancy, eliminate obsolescence, and the like. Prior to inclusion in the manual, all changes must be approved by the DOE Hoisting and Rigging Committee, which meets semi-annually, and by the Headquarters Office of Occupational Safety and Health Policy, which has safety responsibility for DOE hoisting and rigging. The Committee is also a major source for input into the manual, particularly concerning those areas that are not defined or are only generally defined by Federal and national standards, such as training and qualification, and those concerning the DOE's unique operational environment, such as hoisting and rigging over nuclear reactors and other locations containing critical equipment. In the years that minor revisions occur, only the changed pages, usually 8 to 10, are sent to individuals on the distribution list. After two to three such supplements, the manual is reissued in its entirety, which incorporates the previous supplements plus the most recent unpublished changes approved by the committee. An example is the complete revision issued in 1993 followed by another complete revision in 1996, 1999 and 2001 without any intervening supplements. In this case, the supplements were omitted because of the numerous improvements incorporated within the very short time period. Some of the most notable changes in the current standard include:

1. Full compliance with OSHA and ANSI requirements, with the OSHA requirements having priority where conflicts exist.

2. Expansion of Chapter 6 to include greater detail on qualifications for a larger number of positions. Criteria to be evaluated in training programs have likewise been expanded, enabling sites to tailor training programs to their particular characteristics.

3. The complete reformatting of each section into major equipment categories so that the handbook is easier to use.

4. The use of double-column format along with a slightly larger font size which improves readability. The double-column format has the added advantage of placing figures and tables closer to their referencing text.

5. Labeling of the side-by-side good practice, bad practice drawings so that the information being conveyed is immediately apparent. Also, in some cases portions of drawings containing key information, such as hand signals, finger positions were difficult to discern. These have been retouched.

6. This document contains many common element requirements which differ slightly in wording when applied to a specific equipment type. These differences have been compared, and whenever appropriate, the most comprehensive (and clearest) wording has been used.

7. To improve readability, the writing style has been changed to the active voice, which reduces, to some extent, the use of the word "shall," indicating a mandatory requirement. The reader should note that the use of the active (imperative) voice, such as "ensure that, check for, use only," indicates a mandatory requirement even if the word "shall" is not present in the sentence.

8. The reissued June '95 edition marked a change in classification. The DOE Office of Scientific and Technical Information (OSTI) reclassified the manual as a handbook and was issued as DOE Hoisting and Rigging Handbook (DOE-HDBK-1090-95). After further review, OSTI has reclassified the handbook as a DOE Technical Standard and the September 1996 edition was issued as DOE STANDARD HOISTING AND RIGGING (Formerly Hoisting and Rigging Manual) DOE-STD-1090-96 (Rev-1). Additional revisions issued are DOE-STD-1090-99 and DOE-STD-1090-2001

While *The Hoisting and Rigging Standard* is in itself a best practice document, much of its content, such as the OSHA, ANSI/ASME, and Crane Manufacturers Association of America standards, is mandatory within DOE. In addition, many DOE organizations have, on their own initiative, adopted the standard as mandatory to ensure safe and proper hoisting and rigging operations at their facilities. Whether mandatory or not, the standard is and will continue to be the standard by which the excellence of DOE hoisting and rigging programs are judged.

Acknowledgment

The Department of Energy (DOE) acknowledges the many organizations whose documents provided important source material for the standard. They include:

American Society of Mechanical Engineers

ASME B30.2, “Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)”

ASME B30.5, “Crawler, Locomotive, and Truck Cranes”

ASME B30.9, “Slings”

ASME B30.10, “Hooks”

ASME B30.16, “Overhead Hoists (Underhung)”

ASME B30.17, “Overhead and Gantry Cranes (Top Running Bridge, Single Girder Underhung Hoist)

ASME B30.20, “Below-the-Hook Lifting Devices”

ASME B30.21, “Manually Lever Operated Hoist”

ASME B30.22, “Articulating Boom Cranes”

ASME B30.23, “Personnel Lifting Systems”

ASME B56.1, “Low Lift and High Lift Trucks”

ASME B56.6, “Rough Terrain Forklift Trucks”

ASME PALD, “Portable Automotive Lifting Devices”

ASME MH11.4, “Forks and Fork Carriers for Powered Industrial Fork Lift Trucks”

Construction Safety Association (CSA) of Ontario

"The Rigging Handbook"

Society of Automotive Engineers, Inc. (SAE)

SAE J1028, "Mobile Crane Working Area Definitions”

Permission to reprint specific figures and illustrations was obtained from CSA and SAE. Applicable sections of 29 CFR 1910, "Occupational Safety and Health Standards for General Industry," and 29 CFR 1926, "Occupational Safety and Health Regulations for Construction," have been paraphrased or reproduced verbatim throughout. The contributions of DOE's Hoisting and Rigging Committee, which has met semi-annually since 1980, is also recognized. Representing many DOE sites, this group has provided advice and clarification of the codes and standards that form the underlying basis for this document. Without their time and talent, which has been provided gratuitously, there would be no standard.

Other significant contributors include the two editors, Ingeborg Westfall and Marshall Henrie, whose considerable efforts resulted in several of the substantive improvements described in the History and Background section, and whose changes regarding text, format, and spelling have improved the standard to what we believe is the equivalent of desktop-publishing quality and in doing so increased its usefulness to the hoisting and rigging community. The Department is also greatly indebted to Kay Johnson, now retired, who, during his 10-year tenure as program coordinator, perhaps more than any other person, was responsible for developing the standard into the truly invaluable document that it is today.

The standard is a safety, not a design, document intended for use by safety professionals and managers. In keeping with this philosophy, only those portions of standards and regulations dealing with safety, particularly those deemed most relevant to DOE operations, have been included. While it is convenient to have focused, indepth hoisting and rigging safety information concentrated into one document, the significance of the above source material is acknowledged, and readers are strongly encouraged to review each of them so as to have a full description of the subject area covered.

Introduction

The U.S. Department of Energy (DOE) *Hoisting and Rigging Standard* is intended as a reference document to be used by supervisors, line managers, safety personnel, equipment operators, and any other personnel responsible for safety of hoisting and rigging operations at DOE sites. The standard quotes verbatim or paraphrases (with minor editorial changes for consistency) the requirements of the U.S. Occupational Safety and Health Administration (OSHA) and the American National Standards Institute (ANSI). It also encompasses, under one cover, hoisting and rigging requirements, codes, standards, and regulations, eliminating the need to maintain extensive (and often incomplete) libraries of hoisting and rigging standards throughout DOE.

As indicated in the History and Background section, the use of the imperative voice (as in "Never use discarded load chain for slings") or the word "shall" denotes a mandatory action, whereas use of the word "should" denotes a recommended action in keeping with best management practices.

From chapter to chapter, the reader may notice what appears to be excessive repetition. Such repetition, however, is by design, enabling the use of each chapter, if needed or convenient, as a stand-alone document.

The standard occasionally goes beyond the minimum general industry standards established by OSHA and ANSI; and also delineates the more stringent requirements necessary to accomplish the extremely complex, diversified, critical, and oftentimes hazardous hoisting and rigging work found within the DOE complex. In doing so, it addresses the following items which are not covered in detail in the general industry standards:

1. Management responsibility and accountability
2. Operator/inspector training and qualification requirements
3. Definition of critical lifts and the additional requirements for making them
4. The need and responsibilities of a person-in-charge for critical lifts
5. The need and responsibilities of a designated leader for ordinary lifts
6. The definition and special requirements for preengineered production lifts
7. Special requirements for the testing, inspection, and maintenance of hoisting equipment in hostile environments
8. Nondestructive testing/nondestructive examination requirements for such items as hooks, welds, and spreader bars
9. Special requirements for inspection and load-testing of hoisting and rigging equipment/accessories
10. Hook latch requirements for cranes, slings, and rigging accessories
11. Design standards for such equipment as cranes, forklifts, and hooks
12. Operating practices for hoisting and rigging operations
13. Rigging information and load tables
14. Good and bad rigging practices.

Because the possibility of serious accidents resulting in personnel injury or death or significant property damage exists whenever hoisting and rigging take place, the requirements for these operations must be clearly defined and precautions ensured, including proper preplanning, extreme care, attention to detail, teamwork on the part of trained operators/riggers, and the use of equipment that is reliable, properly designed, inspected, and maintained. Although not mandatory at all DOE sites and locations, this standard has been used for many years by DOE and its contractors as a valuable resource for conducting hoisting and rigging safely and efficiently and as the standard against which to judge all hoisting and rigging programs. The full implementation of the requirements and recommendations of this standard will dramatically strengthen hoisting and rigging programs throughout the DOE complex and will significantly decrease the probability of serious accidents resulting in personnel injury or death or severe property damage.

To propose improvements to the standard, please use the copy of the form at the back. All requests or suggestions for improvement should be submitted to:

Hoisting and Rigging Project Manager
U.S. Department of Energy
EH-53, 270 CC
19901 Germantown Road
Germantown, MD 20874-1290

CHAPTER 1
TERMINOLOGY AND DEFINITIONS

The following are specialized terms commonly used when discussing hoisting and rigging operations. Many may not be used in this standard but are included for general information. The terms are arranged in alphabetical order. Illustrations are included for clarity.

ABRASION: Surface wear.

ACCELERATION STRESS: Additional stress imposed due to increasing load velocity.

ALTERNATE LAY: Lay of wire rope in which the strands are alternately regular and lang lay.

ANSI: American National Standards Institute.

APPOINTED: Assigned specific responsibilities by the employer or the employer's representative.

AREA, METALLIC: Sum of the cross-sectional areas of individual wires in a wire rope or strand.

ATTACHMENT: A device other than conventional forks or load backrest extension, mounted permanently or removably on the elevating mechanism of a truck for handling the load. Popular types are fork extension clamps, rotating devices, side shifters, load stabilizers, rams, and booms.

AUTHORIZED: Assigned by a duly constituted administrative or regulatory authority.

AUXILIARY HOIST: Supplemental hoisting unit of lighter capacity and usually higher speed than the main hoist.

BACK STAY: Guy used to support a boom or mast or that section of a main cable, as on a suspension bridge, or cableway, and the like, leading from the tower to the anchorage.

BAIL: A U-shaped member of a bucket, socket, or other fitting.

BASKET OR SOCKET: The conical portion of a socket into which a splayed rope end is inserted and secured with zinc.

BATTERY-ELECTRIC TRUCK: An electric truck in which the power source is a storage battery.

BECKET LOOP: A loop of small rope or a strand of rope fastened to the end of a large wire rope to facilitate installation.

BENDING STRESS: Stress on wires of a wire rope imposed by bending. This stress need not be added to direct load stresses. When sheaves and drums are of suitable size, bending stress does not affect the normal life of the wire rope.

BIRDCAGE: A colloquialism describing the appearance of a wire rope that is forced into compression. The outer strands form a “cage” and at times displace the core.

BIRDCAGING: The twisting of fiber or wire rope in an isolated area in the opposite direction of the rope lay, causing it to take on the appearance of a birdcage.

BOOM (CRANE): A member hinged to the rotating superstructure and used for supporting the hoisting tackle.

BOOM LINE: A wire rope for supporting or operating the boom on derricks, cranes, draglines, shovels, and the like.

BRAKE: A device used for slowing or stopping motion by friction or electromagnetic means.

BRAKE, DRAG: A brake that provides stopping force without external control.

BRAKE, HOLDING: A brake that sets automatically and that prevents motion when power is off.

BRAKE, PARKING: A device to prevent the movement of a stationary vehicle.

BRAKING, COUNTER TORQUE: A method of stopping motion in which the power to the motor is reversed to develop torque in the opposite direction.

BRAKING, DYNAMIC: A method of controlling crane motor speeds when in the overhauling condition to provide a retarding force.

BRAKING, MECHANICAL: A method of slowing motion by friction.

BRAKING, REGENERATIVE: A form of dynamic braking in which the electrical energy generated is fed back into the power system.

BREAKING STRENGTH: The measured load required to break a wire rope or chain.

BRIDGE: The part of a crane, consisting of girders, walkways, railings, trucks, and drive mechanisms, that carries the trolley or trolleys.

BRIDGE TRAVEL: Horizontal travel of the crane parallel with runway rails.

BRIDLE SLING: A sling composed of multiple legs (branches), the top ends of which terminate in a fitting that latches onto the lifting hook.

BULL RING: The main large ring of a sling to which sling legs are attached.

BUMPER (BUFFER): An energy-absorbing device for reducing impact when a moving overhead crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact.

CAB: The operator's compartment.

CABLE: A term loosely applied to wire ropes, wire strands, manila ropes, and electrical conductors.

CABLE-LAID WIRE ROPE: A type of wire rope consisting of several independent wire ropes laid into a single wire rope.

CABLE CROWD ROPE: A wire rope used to force the bucket of a power shovel into the material being handled.

CANTILEVER TRUCK: A self-loading counterbalanced or noncounterbalanced truck equipped with cantilever load-engaging means, such as forks (see Figure 10-3).

CARRIAGE: A support structure for forks or attachments, generally roller-mounted, traveling vertically within the mast of a cantilever truck.

CENTER: A single wire or fiber in the center of a strand around which the wires are laid.

CENTER CONTROL: The position near the center of a truck cab from which the operator controls movement of the truck.

CHOKER ROPE: A short wire-rope sling used to form a slip noose around the object to be moved or lifted (see Figure 1-1).

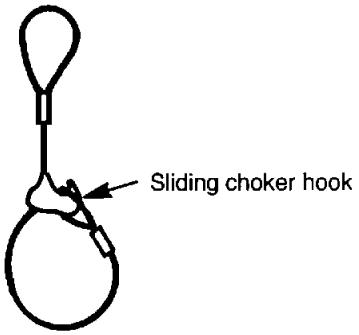


Figure 1-1. Choker rope.

CIRCUMFERENCE: Measured perimeter of a circle circumscribing the wires of a strand or the strands of a wire rope.

CLAMP, STRAND: A fitting used to form a loop at the end of a length of strand; consists of two grooved plates and bolts.

CLEARANCE: The distance by which one object clears another, or the clear space between them.

CLEVIS: A U-shaped fitting with pins.

CLIP: A fitting used to clamp two parts of wire rope.

CLOSED SOCKET: A wire-rope fitting consisting of an integral becket and bail.

CLOSING LINE: Wire rope that closes a clamshell or orange-peel bucket and then operates as a hoisting rope.

COIL: Circular bundle of wire rope not packed on a reel.

COLLECTOR: Contacting device mounted on a bridge or trolley and used to collect current from the conductor system.

COME-ALONG: A portable, hand-operated device consisting of a housing, a length of chain or wire rope, two hooks, and a ratcheting lever, that is used for miscellaneous pulling.

CONDUCTOR: Wire, angles, bars, tees, or special sections mounted to transmit current to the collectors.

CONICAL DRUM: Grooved hoisting drum of varying diameter.

CONSTRUCTION (WIRE ROPE): Refers to the design of wire rope, including number of strands, number of wires per strand, and arrangement of wires in each strand.

CONTINUOUS BEND: Reeving of wire rope over sheaves and drums so that it bends in one direction (as opposed to reverse bend).

CONTROLLER: An operator's device for regulating the power delivered to a motor or other equipment.

CONTROLLER, SPRING RETURN: A controller that, when released, will return automatically to a neutral position.

CORE: The center member of a wire rope around which the strands are laid. It may be fiber, a wire strand, or an independent wire rope.

CORING LINE: Wire rope used to operate the coring tool for taking core samples during the drilling of a well.

CORROSION: Chemical decomposition by exposure to moisture, acids, alkalies, or other destructive agents.

CORRUGATED: A term used to describe the grooves of a sheave or drum when worn so as to show the impression of a wire rope.

COUNTERBALANCED TRUCK: A truck equipped with load-engaging means wherein, during normal transporting, all the load is external to the polygon formed by the wheel contacts (see Figure 10-3).

COVER WIRES: The outer layer of wires.

CRANE: A machine used for lifting and lowering a load vertically and moving it horizontally and that has a hoisting mechanism as an integral part of it.

CRANES, TYPES OF:

Automatic Crane: A crane that, when activated, operates through a preset cycle or cycles.

Cab-Operated Crane: A crane controlled by an operator in a cab located on the bridge or trolley.

Cantilever Gantry Crane: A gantry or semigantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

Floor-Operated Crane: A crane whose operation is controlled by use of a pendant in the hands of an operator on the floor or on an independent platform.

Gantry Crane: A crane similar to an overhead crane, except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

Jib Crane: A fixed crane with a vertical rotating member supported at the bottom (also at the top in some types) from which an arm extends to carry the hoist trolley. Jib cranes are most commonly mounted on a vertical column, supplied as part of the jib crane, or on existing structural members (e.g., a wall-mounted jib crane).

Mobile Crane: For the purposes of this chapter, mobile cranes are defined as wheel-mounted cranes, truck cranes, and crawler cranes.

- A **wheel-mounted** crane consists of a rotating structure with power plant, operating machinery, and boom, mounted on a base or platform equipped with axles and rubber-tired wheels for travel. The base is usually propelled by an engine in the superstructure, but it may be equipped with a separate engine controlled from the superstructure (see Figures 15-1, 15-3, 15-5, 15-6, 15-7, 15-9, and 15-10).

- A **truck-mounted crane** consists of a rotating superstructure with power plant that operates machinery and boom, mounted on an automotive truck equipped with a power plant for travel. Commercial truck-mounted cranes are included in this category (see Figures 15-3, 15-7, 15-9, and 15-10).

- A **crawler crane** consists of a rotating superstructure with power plant, operating machinery and boom, mounted on a base equipped with crawler treads for travel (see Figures 15-2 and 15-8).

Overhead Traveling Crane: A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed-runway structure.

Power-Operated Crane: A crane whose mechanism is driven by electricity, air, hydraulics, or internal combustion.

Pulpit-Operated Crane: A crane operated from a fixed operator station that is not attached to the crane.

Remote-Operated Crane: A crane controlled by an operator not in a pulpit or a cab attached to the crane, by any method other than pendant or rope control (e.g., radio-controlled crane).

Semigantry Crane: A gantry crane with one end of the bridge rigidly supported on one or more legs that run on a fixed rail or runway, the other end of the bridge being supported by a truck running on an elevated rail or runway.

Shop Crane: A Portable Automotive Lifting Device (PALD), self contained hydraulic and pneumatic-hydraulic crane characterized by a pair of laterally spaced legs, an upright mast, a pivoting boom with a boom extension and hook, and a hydraulic unit. The hydraulic unit moves the boom up and down at a pivot point for the purpose of raising, removing, transporting in the lowered position, and replacing automotive engines, transmissions and other components. Shop cranes have a capacity of 4 tons (8000 pounds) or less.

Wall-Mounted Crane: A crane having a jib, with or without a trolley, supported from a side wall or line of columns of a building. It is a traveling-type crane and operates on a runway attached to the side wall or line of columns.

Wall-Mounted Jib Crane: See Cranes, Types Of, Jib Crane.

CRITICAL DIAMETER: Diameter of the smallest bend for a given wire rope that permits the wires and strands to adjust themselves by relative movement while remaining in their normal positions.

CYLINDRICAL DRUM: Hoisting drum of uniform diameter.

DECELERATION STRESS: Additional stress imposed on a wire rope due to decreasing the load velocity.

DEFLECTION:

- Sag of a rope in a span, usually measured at midspan as the depth from a chord joining the tops of the two supports.

- Any deviation from a straight line.

DESIGN FACTOR: Ratio of ultimate strength to the design working stress.

DESIGNATED: Selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

DESIGNATED LEADER: "An individual assigned responsibility for hoisting and rigging activities requiring more than one person".

DIAMETER: Distance measured across the center of a circle circumscribing the wires of a strand or the strands of a wire rope.

DIESEL-ELECTRIC TRUCK: An electric truck in which the power source is a generator driven by a diesel engine.

DOCKBOARD: A portable or fixed device for spanning the gap or compensating for the difference in level between loading platforms and carriers.

DOG-LEG: Permanent short bend or kink in a wire rope caused by improper use.

DRAGLINE: Wire rope used to pull an excavating or drag bucket.

DRIVE: Motor, coupling, brake and gear case, or gear cases used to propel bridge, trolley, or hoist.

DRIVE GIRDER: A girder on which is mounted the bridge drive, cross shaft, walk, railing, and operator's cab.

DRUM: A cylindrical-flanged barrel of uniform (cylindrical drum) or tapering (conical drum) diameter on which a wire rope is wound for operation or storage. It may be smooth or grooved.

ELASTIC LIMIT: Limit of stress beyond which a permanent deformation takes place within the material. This limit is approximately 55–65 percent of breaking strength of steel-wire ropes.

ELECTRIC TRUCK: A truck in which the principal energy is transmitted from power source to motor(s) in the form of electricity.

END CONTROL: An operator-control position that is located at the end opposite the load end of the truck.

EQUALIZER: A device used to compensate for unequal length or stretch of a hoist rope.

EQUALIZING SLINGS: Slings composed of wire rope and equalizing fittings.

EQUALIZING THIMBLES: A special type of fitting used as a component part of some wire-rope slings.

EYE OR EYE SPLICE: A loop with or without a thimble formed in the end of a wire rope.

FAIL-SAFE: A provision designed to automatically stop or safely control any motion in which a malfunction could occur.

FATIGUE: The tendency of a material to break under repeated stress.

FIBER CENTERS: Cords or rope made of vegetable fiber used in the center of a strand.

FIBER CORES: Cords or rope made of vegetable fiber used in the core of a wire rope.

FIRST POINT: The first setting on the operator's controller that starts crane motion (slowly) in each direction.

FITTING: Any accessory used as an attachment for wire rope.

FLAG: Mark or marker on a rope to designate position of load.

FLAT ROPE: Wire rope made of parallel alternating right-lay and left-lay ropes sewn together by relatively soft wires.

FLATTENED STRAND ROPE: A wire rope with either oval or triangular strands that present a flattened rope surface.

FLEET ANGLE: Angle between the position of a rope at the extreme end wrap on a drum and a line drawn perpendicular to the axis of the drum through the center of the nearest fixed sheave.

FORKS: Horizontal tine-like projections, normally suspended from the carriage, used to engage and support loads.

FORK HEIGHT: The vertical distance from the floor to the load-carrying surface adjacent to the heel of the forks with the mast vertical, and in the case of reach trucks, with the forks extended.

FORKLIFT TRUCK: A high-lift self-loading truck equipped with load carriage and forks for transporting and tiering loads (see Figure 10-3).

GALVANIZE: To coat with zinc to protect against corrosion.

GALVANIZED ROPE: Rope made of galvanized wire.

GALVANIZED STRAND: Strand made of galvanized wire.

GALVANIZED WIRE: Wire coated with zinc.

GAS-ELECTRIC TRUCK: An electric truck in which the power source is a generator driven by an LP-gas or gasoline engine.

GROMMET: A seven-strand wire-rope sling made from one continuous length of strand or an endless synthetic-web sling.

GROOVED DRUM: Drum with grooved outer surface to accommodate and guide a rope.

GROOVES: Depressions in the outer surface of a sheave or drum for positioning and supporting a rope.

GUY LINE: Strand or rope, usually galvanized, for holding a structure in position.

HANDLING FIXTURE: A cradle, structure, shipping fixture, or container designed specifically to facilitate supporting, lifting, or handling a component during fabrication, loading, shipping, storage, or installation.

HIGH-LIFT TRUCK: A self-loading truck equipped with an elevating mechanism designed to permit tiering. Popular types are high-lift platform trucks (see Figure 10-3).

HIGH-LIFT PLATFORM TRUCK: A self-loading truck equipped with an elevating mechanism intended primarily for transporting and tiering loaded skid platforms (see Figure 10-3).

HOIST: A device that applies a force for lifting or lowering.

HOIST, LEVER OPERATED: A lever-operated manual device used to lift, lower, or pull a load and to apply or release tension.

HOLDING LINE: Wire rope on a clamshell or orange-peel bucket that holds the bucket while the closing line is released to dump the load.

HOOK LOAD: The total live weight supported by the hook of a crane, derrick, or other hoisting equipment, including the load, slings, spreader bars, and other tackle not part of the load but supported by the hook and required for the handling of the load.

IDLER: Sheave or roller used to guide or support a rope.

INDEPENDENT WIRE-ROPE CORE: Wire rope used as the core of a larger rope.

INNER WIRES: All wires of a strand except surface or cover wires.

INTERNAL-COMBUSTION ENGINE TRUCK: A truck in which the power source is a gas or diesel engine.

INTERNALLY LUBRICATED: Wire rope or strand having all wires coated with lubricant.

KINK: Permanent distortion of wires and strands resulting from sharp bends.

LAGGING: External wood covering on a reel of rope or a strand.

LANG-LAY ROPE: Wire rope in which the wires in the strands and the strands in the rope are laid in the same direction.

LAY LENGTH: The lengthwise distance on a wire rope in which a strand makes one complete turn around the rope's axis (see Figure 1-2).

Figure 1-2. Rope Lay

Left Lay:

- **Strand:** Strand in which the cover wires are laid in a helix having a left-hand pitch, similar to a left-hand screw.
- **Rope:** Rope in which the strands are laid in a helix having a left-hand pitch, similar to a left-hand screw.

Right Lay:

- **Strand:** Strand in which the cover wires are laid in a helix having a right-hand pitch, similar to a right-hand screw.
- **Rope:** Rope in which the strands are laid in a helix having a right-hand pitch, similar to a right-hand screw.

LIFT:

- Maximum safe vertical distance through which a hook can travel.
- The hoisting of a load.

LIFT, CRITICAL: A lift for which the application of requirements applicable to ordinary lifts would not adequately eliminate or control the likelihood or severity of the following:

- personnel injury or significant adverse health impact (onsite or offsite).
- significant release of radioactivity or other hazardous material or other undesirable conditions.
- undetectable damage that would jeopardize future operations or the safety of a facility.
- damage that would result in delay to schedule or other significant program impact such as loss of vital data.

LIFT, ORDINARY: Any lift not designated as a critical lift or a preengineered production lift.

LIFT, PREENGINEERED PRODUCTION: Repetitive, production-type lifting operation, independent of the nature of the load to be lifted, in which the probability of dropping, upset, or collision is reduced to a level acceptable to the responsible manager by preliminary engineering evaluation, specialized lifting fixtures, detailed procedures, operation-specific training, and independent review and approval of the entire process.

LINE: A rope used for supporting and controlling a suspended load.

LOAD: The total weight superimposed on the load block or hook.

LOAD BLOCK: The assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting ropes.

LOAD-BACKREST EXTENSION: A device extending vertically from the fork carriage frame.

LOAD-BEARING PARTS: Any part of a material-handling device in which the induced stress is influenced by the hook load. *A primary* load-bearing part is a part the failure of which could result in dropping, upset, or uncontrolled motion of the load. Load-bearing parts which, if failed, would result in no more than stoppage of the equipment without causing dropping, upset, or loss of control of the load are not considered to be primary load-bearing parts.

LOAD CENTER (FORKLIFTS): The horizontal longitudinal distance from the intersection of the horizontal load-carrying surfaces and vertical load-engaging faces of the forks (or equivalent load-positioning structure) to the center of gravity of the load.

LOW-LIFT TRUCK: A self-loading truck equipped with an elevating mechanism designed to raise the load only sufficiently to permit horizontal movement (see Figure 10-3).

MAGNET: An electromagnetic device carried on a crane hook and used to pick up loads.

MAIN HOIST: The hoist mechanism provided for lifting the maximum-rated load.

MAN TROLLEY: A trolley having an operator's cab attached to it.

MARLINE SPIKE: Tapered steel pin used in splicing wire rope.

MESSENGER STRAND: Galvanized strand or bronze strand used to support telephone and electrical cables.

MODULUS OF ELASTICITY: Mathematical quantity giving the ratio, within the elastic limit, between a definite range of unit stress on a wire rope and the corresponding elongation.

MOUSING: A method of bridging the throat opening of a hook to prevent the release of load lines and slings, under service or slack conditions, by wrapping with soft wire, rope, heavy tape, or similar materials.

NARROW-AISLE TRUCK: A self-loading truck intended primarily for right-angle stacking in aisles narrower than those normally required by counterbalanced trucks of the same capacity (see Figure 10-3).

NONDESTRUCTIVE EXAMINATION (NDE): The development and application of technical methods to examine materials or components, in ways that do not impair future usefulness and serviceability, in order to detect, locate, measure, and evaluate discontinuities, defects, and other imperfections; to assess integrity, properties, and composition; and to measure geometrical characteristics.

NONDESTRUCTIVE TESTING (NDT): See NONDESTRUCTIVE EXAMINATION.

NONROTATING WIRE ROPE: See Rotation-Resistant Wire Rope.

OPEN SOCKET: A wire-rope fitting consisting of a basket and two ears with a pin.

ORDER-PICKER TRUCK, HIGH-LIFT: A truck, controllable by an operator stationed on a platform, which is movable, has a load-engaging means, and is intended for (manual) stock selection. The truck may be capable of self-loading and/or tiering (see Figure 10-3).

OVERHEAD GUARD: A framework fitted to a truck over the head of a riding operator.

PALLET TRUCK: A self-loading, non-motorized or motorized low-lift truck equipped with wheeled forks of dimensions sized to go between the top and bottom boards of a double-faced pallet, the wheels fitting into spaces between the bottom boards, so as to raise the pallet off the floor for transporting (see Figure 10-3).

PEENING: Permanent distortion of outside wire in a rope caused by pounding.

PERSON-IN-CHARGE (PIC): The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads.

POWERED INDUSTRIAL TRUCK: A mobile, power-driven vehicle used to carry, push, pull, lift, stack, or tier material.

PRECISION LOAD POSITIONING DEVICES: A rigging accessory designed specifically to precisely raise and lower a load through a limited range of lifting/lowering motion (stroke). Standards units typically have 12 in. (30 cm) stroke and can position a load within 0.001 in. (0.025 mm). These devices commonly include a built-in load scale and in such cases may also serve as a load-indicating device.

PREFORMED WIRE ROPE: Wire rope in which the strands are permanently shaped, before being fabricated into the rope, to the helical form they assume in the wire rope.

PREFORMED STRAND: Strand in which the wires are permanently shaped, before being fabricated into the strands, to the helical form they assume in the strand.

PRESTRESSING: Stressing a wire rope or strand before use under such a tension and for such a time that stretch that would otherwise occur once the load is picked up is largely nonexistent.

PROOF TEST: A nondestructive tension test performed to verify construction and workmanship of slings or rigging accessories.

PUBLIC CARRIER: A for-hire company engaged in the public transportation of goods.

QUALIFIED: A person who, by possession of a recognized degree, certificate, or professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated an ability and competence to solve or resolve problems relating to the subject matter and work.

QUALIFIED ENGINEER/QUALIFIED ENGINEERING ORGANIZATION: An engineer or engineering organization whose competence in evaluation of the type of equipment in question has been demonstrated to the satisfaction of the responsible manager.

QUALIFIED INSPECTOR: One whose competence is recognized by the responsible manager and whose qualification to perform specific inspection activities has been determined, verified, and attested to in writing.

QUALIFIED OPERATOR: One who has had appropriate and approved training, including satisfactory completion of both written and operational tests to demonstrate knowledge, competence, and skill, in the safe operation of the equipment to be used.

QUALIFIED RIGGER: One whose competence in this skill has been demonstrated by experience satisfactory to the appointed person.

NOTE: The term "rigger" or "qualified rigger" in this standard refers to the function performed, and in no way relates to the worker's classification in any union or bargaining unit.

RATED CAPACITY: The maximum hook load that a piece of hoisting equipment is designed to carry; also the maximum load that an industrial truck or a sling, hook, shackle, or other rigging tackle is designed to carry.

NOTE: At the option of the user, a rated capacity can be assigned that is less than the design-rated capacity.

REACH TRUCK: A self-loading truck, generally high-lift, having load-engaging means mounted so it can be extended forward under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Figure 10-3).

REEL: The flanged spool on which wire rope or strand is wound for storage or shipment.

REEVING: A system in which a rope travels around drums or sheaves.

REGULAR-LAY ROPE: Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.

REVERSE BEND: Reeving of a wire rope over sheaves and drums so that it bends in opposite directions.

RIDER TRUCK: A truck that is designed to be controlled by a riding operator.

RIGGING: The hardware or equipment used to safely attach a load to a lifting device. The art or process of safely attaching a load to a hook by means of adequately rated and properly applied slings and related hardware.

ROLLERS: Relatively small-diameter cylinders or wide-faced sheaves used for supporting or guiding ropes.

ROTATION-RESISTANT WIRE ROPE: Wire rope consisting of a left-lay, lang-lay inner rope covered by right-lay, regular-lay outer strands.

RUNNING SHEAVE: A sheave that rotates as the load block is raised or lowered.

RUNWAY: Assembly of rails, girders, brackets, and framework on which a crane operates.

SAFE WORKING LOAD: Load that a rope may carry economically and safely.

SEALE: A strand construction having one size of cover wires with the same number of one size of wires in the inner layer and each layer having the same length and direction of lay. Most common construction is one center wire, nine inner wires, and nine cover wires.

SEIZE: To securely bind the end of a wire rope or strand with seizing wire or strand.

SEIZING STRAND: Small strand, usually of seven wires, made of soft-annealed-iron wire.

SEIZING WIRE: A soft-annealed-iron wire.

SELF-LOADER: A truck with tires that can fit between the top and bottom boards of a double-faced pallet.

SERVE: To cover the surface of a wire rope or strand with a wrapping of wire.

SHACKLE: A type of clevis normally used for lifting (see Figure 1-3).

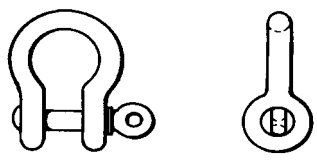


Figure 1-3. Shackle.

SHALL: A word indicating that an action is mandatory.

SHEAVE: A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

SHEAVE, NONRUNNING (EQUALIZER): A sheave used to equalize tension in opposite parts of a rope, called nonrunning because of its slight movement.

SHEAVE, RUNNING: A sheave that rotates as the load block is lifted or lowered.

SHOULD: A word indicating a recommended action, the advisability of which depends on the facts in each situation.

SIDE LOADER: A self-loading truck, generally high-lift, having load-engaging means mounted in such a manner that it can be extended laterally under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Figure 10-3).

SIDE PULL: That portion of a hoist pull acting horizontally when the hoist lines are not operated vertically.

SLINGS: Wire ropes, chains, synthetic web, and metal mesh made into forms, with or without fittings, for handling loads.

SLINGS, BRAIDED: Very flexible slings composed of several individual wire ropes braided together.

SMOOTH-FACED DRUM: Drum with a plain, not grooved, face.

SPAN: The horizontal, center-to-center distance of runway rails.

SPIRAL GROOVE: Groove that follows the path of a helix around a drum, similar to the thread of a screw.

SPLICING: Interweaving of two ends of rope to make a continuous or endless length without appreciably increasing the diameter. Also refers to making a loop or eye in the end of a rope by tucking the ends of the strands.

Splice, Hand Tucked: A loop or eye formed in the end of a rope by tucking the end of the strands back into the main body of the rope in a prescribed manner.

Splice, Mechanical: A loop or eye formed in the end of a wire rope by pressing or swaging one or more metal sleeve over the wire rope junction.

STAINLESS-STEEL ROPE: Wire rope made of chrome-nickel steel wires having great resistance to corrosion.

STEEL-CLAD ROPE: Rope with individual strands spirally wrapped with flat steel wire.

STRAND: An arrangement of wires helically laid about an axis or another wire or fiber center to produce a symmetrical section.

SUSPECT/COUNTERFEIT ITEMS (S/CI): A suspect item is one in which visual inspection, testing, or other means indicate that it may not conform to established Government or industry-accepted specifications or national consensus standards. A counterfeit item is a suspect item that has been copied or substituted without legal right or authority to do so or one whose material, performance, or characteristics are knowingly misrepresented by the vendor, supplier, distributor, or manufacturer (see Figure 1-5). **NOTE:** (refer to DOE G 440.1-6 "Implementation Guide For Use With Suspect/Counterfeit Requirements" of DOE O 440.1, Worker Protection Management).

SWAGED FITTINGS: Fittings in which wire rope is inserted and attached by a cold-forming method.

SWITCH, ELECTRIC: A device for making, breaking, or changing the connections in an electrical circuit.

SWITCH, EMERGENCY STOP: A manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

SWITCH, LIMIT: A switch that is operated by some part or motion of a power-driven machine or equipment to alter the electrical circuit associated with the machine or equipment.

SWITCH, MAIN: A switch controlling the entire power supply to a crane or other equipment, often called the disconnect switch.

TAG LINE: A rope used to prevent rotation of a load.

TAPERING AND WELDING: Reducing the diameter of the end of a wire rope and welding it to facilitate reeving.

THIMBLE: Grooved metal fitting to protect the eye of a wire rope (see Figure 1-4).

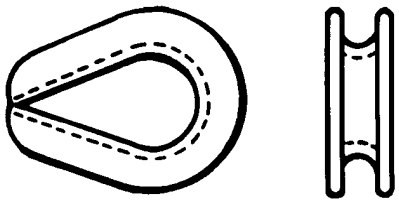


Figure 1-4. Thimble.

TIERING: The process of placing one load on or above another.

TINNED WIRE: Wire coated with tin.

TROLLEY: A unit consisting of frame, trucks, trolley drive, and hoisting mechanism moving on the bridge rails in a direction at right angles to the crane runway.

TROLLEY GIRTS: Structural members that are supported on the trolley trucks and that contain the upper sheave assemblies.

TROLLEY TRAVEL: Horizontal travel of a trolley at right angles to runway rails.

TROLLEY TRUCK: An assembly consisting of wheels, bearings, axles, and structural-supporting hoist mechanism and load girts.

TRUCK, POWERED INDUSTRIAL: A mobile, power-propelled truck used to carry, push, pull, lift, stack, or tier material (see Figure 10-3).

TURNBUCKLE: A device attached to wire rope for making limited adjustments in length. It consists of a barrel and right- and left-hand threaded bolts.

TWO-BLOCKING: The act of continued hoisting in which the load-block and head-block assemblies are brought into physical contact, thereby preventing further movement of the load block and creating shock loads to the rope and reeving system.

VERIFICATION: A procedure in which a design, calculation, drawing, procedure, instruction, report, or document is checked and signed by one or more parties. The one or more persons designated to sign verify, based on personal observation, certified records, or direct reports, that a specific action has been performed in accordance with specified requirements.

WEDGE SOCKET: Wire-rope fitting in which the rope end is secured by a wedge.

WHEEL BASE: Distance between centers of outermost wheels for bridge and trolley trucks.

WHEEL LOAD: The load on any wheel with the trolley and lifted load (rated load) positioned on the bridge to give maximum-loading conditions.

WIRE ROPE: Wire strands laid helically around an axis or a core.

WIRE (ROUND): Single continuous length of metal, cold drawn from a rod.

WIRE (SHAPED): A single continuous length of metal either cold drawn or cold rolled from a rod.

DOE HEADMARK LIST

ANY BOLT ON THIS LIST SHOULD BE TREATED AS DEFECTIVE WITHOUT FURTHER TESTING

ALL GRADE 5 AND GRADE 8 FASTENERS OF FOREIGN ORIGIN WHICH DO NOT BEAR ANY MANUFACTURE'S HEADMARKS:


GRADE 5


GRADE 8

GRADE 5 FASTENERS WITH THE FOLLOWING HEADMARKS:

MARK	MANUFACTURER	MARK	MANUFACTURER
 J	Jinn Her (TW)	 KS	Kosaka Kogyo (JP)

GRADE 8 FASTENERS WITH THE FOLLOWING HEADMARKS:

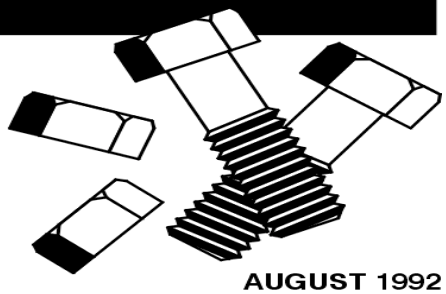
MARK	MANUFACTURER	MARK	MANUFACTURER
 A	Asahi Mfg (JP)	 KS	Kosaka Kogyo (JP)
 E	Dalai (JP)	 M	Minamida Sleybo (JP)
 FM	Fastener Co. of Japan (JP)	 MS	Minato Kogyo (JP)
 H	Hinamoto Metal (JP)	 NF	Nippon Fasteners (JP)
 J	Jinn Her (TW)	 RT	Takai Lid (JP)
 KY	Kyoel Mfg (JP)	 UNY	Unytite (JP)
 Hollow Triangle	Intasco (CA, TW, JP, YU) (Greater than 1/2 inch diameter)		

GRADE 8.2 FASTENERS WITH THE FOLLOWING HEADMARKS:

MARK	MANUFACTURER
 KS	Kosaka Kogyo (JP)

GRADE A325 FASTENERS (BENNETT DENVER TARGET ONLY) WITH THE FOLLOWING HEADMARKS:

	MARK	MANUFACTURER
Type 1	 A325KS	Kosaka Kogyo (JP)
Type 2		
Type 3		



AUGUST 1992

KEY: CA - CANADA JP - JAPAN TW - TAIWAN YU - YUGOSLAVIA

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Figure. 1-5.